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REPORT

OF

THE COMMITTEE

OF THE

Corporation of the City of Ottawa,

AND OF

THE CITY ENGINEER,

ON

WATER WORKS,

Presented to the Council on Monday, 24th April,
1871.

PRINTED BY ORDER OF THE CORPORATION.

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1871.

COMMITTEE REPORT.

The Corporation of the City of Ottawa :

The Committee on Water Works beg leave, in this their third Report, to state that having thoroughly investigated every subject connected with the present outlay of the citizens for water for public and private purposes they find that the cost of the Fire Department is $5,000, for water at fires, $1,000. There are thirty-one licensed carters or water carriers in the city, working on the average three hundred and ten days in the year, and earning about $2 per day cash, being a total of $19,220 per annum. Allowing that they make an average of ten trips per day, and carry fifty gallons per trip, the whole amount delivered would be 15,500 gallons per diem, and this probably supplies one-fourth of the population. This would only give 3 gallons per head per diem of water, by no means pure or good, to those supplied from this source, and Your Committee submit that the labour of procuring water by the remaining three-fourths of the population in carrying from the public wells, hauling by private conveyances, and the sinking of wells, building of tanks, and cisterns would at least represent a like amount, or one-third the sum to the individual, as to those supplied by water carriers.

The Corporation expended during the past year in wells and pumping machinery $1,200, and $250 more in cleaning, repairs, and keeping them free from ice, making a total of $1,450.00. They also expended in watering Sapper's Bridge $100, while $1,000 has been expended by private individuals in watering Duke, Wellington, Sparks, Sussex, and Rideau streets. Thus the actual amount expended individually and collectively by the citizens for a very scanty and impure supply during the past year would be as follows :—

Public :—		
Fire Department	$ 6,000	
City Wells	1,450	
Sapper's Bridge	100	
		$ 7,550
Individuals :—		
By Carters	$19,220	
Watering streets	1,000	
		20,220
Money and labor expended by the remaining three-fourths of population		19,220
		$46,990

To this must be added the difference between rates of insurance as they are at present without, and as they would be, according to the best authorities, with an efficient system of water supply.

It appears from the best information to Your Committee available, that the premiums paid on the property insured in the city of Ottawa during the past year was from $75,000 to $80,000, and this was on seven-sixteenths of the property, representing say one-third of the value of the whole, which, with an efficient system of water works, insurance agents state could and would be reduced from 33⅓ to 50 per cent below the rate of last year. Taking the lesser percentage of 33⅓ off the $75,000 paid it would cause a deduction or saving of $25,000 which would have to be added to the amount above stated. Now, taking this as a data, if the whole insurable property was insured the premiums would amount to $225,000. Subtract from this the said 33⅓ per cent—the actual deduction or saving would be $150,000 per annum, leaving the whole city insured, for Your Committee cannot make any difference between the property holder being his own insurer or availing himself of the advantages and benefits of the Insurance Companies. And Your Committee are informed by the Insurance agents that since the last disastrous fire, by which the premises of Hunton, Shoolbred & Co. were destroyed, they have been instructed by their principals not to take or continue risks at less than an advance of fifty per cent over the previous rates, which would increase the premiums payable annually on the present policies in the city to $112,500, or upon the whole city to the enormous sum of $337,500, or four times the annual city taxes, the whole of which may be summed up in the following figures:

Fire Department	$ 6,000
City wells	1,450
Watering streets	1,000
Paid to carters	19,000
Labor and means otherwise expended, a like sum	19,000
Amount saved on last rate of insurance on present premiums	25,000
Total	$71,990

If we then add to this already large sum $50,000, being the amount payable if the remainder of the city was insured, we have the annual net saving of $121,990, and at the present rate of Insurance the saving is so large that Your Committee hesitate to name it, being on the whole city no less than $187,500, making a present total saving or benefit on the whole city of $234,490 in favour of water works.

Your Committtee have had before them the estimate of Mr. Keefer for Water Works, which amounted to $250,000, including a fire alarm telegraph, and the report and estimates of the City Engineer, Mr. Perry, which they now hand in to you as follows:—The gully route, $470,000; Queen street, $437,000; Oregon street, $430,000; Amelia Island, $403,000; Victoria Island, $410,000; Little Chaudiere, $450,000; steam, $375,000.

Thus the present outlay and the saving on the late rate of insurance on the present premiums would give a return of $28\frac{4}{5}$ per cent on Mr. Keefer's estimate, and on the highest of Mr. Perry's estimates $15\frac{1}{3}$ per cent per annum, and if the whole city was insured at the late rates of insurance on Mr. Keefer's estimate would give $48\frac{4}{5}$ per cent, and on Mr. Perry's estimate 26 per cent, while at the present rate of insurance on the present premiums on Mr. Keefer's estimate would be 44 per cent, and on Mr. Perry's $23\frac{2}{5}$, while if the whole city was insured at present rates there would be on Mr. Keefer's estimate $93\frac{3}{5}$ per cent, and on Mr. Perry's estimate a fraction under 50.

Your Committee having shown the benefits arising from Water Works pecuniarily will now consider the annual outlay attending the same, and first taking for a basis the highest estimate submitted to them, being $470,000. Your Committee submit that at the present favourable state of the money market funds would be available at six per cent, and as the statute provides for 30 year's debentures for this purpose two per cent of a sinking fund would be amply sufficient. Therefore, the amount charged for interest would be $28,200; for sinking fund. $9,400; total, $37,-

To this should be added the sum of $15 per day, for working expenses, amounting to $5,475, or a total annual charge of $43,075.

To provide for which, your Committee submit taking our population at 25,000, and according to present statistics it would require 4,140 houses to accommodate that number. They submit the following as a basis for the water rates to be established, making no distinction between real and personal estate, nor allowing any reduction for existing liabilities, under sub. sec. 19 of sec. 936 Vic. All vacant lots on the line of the water pipes $2.00 annually and a like sum on all properties valued at $400; on property rated from $400 to $1,000 the sum of $3.00, and one dollar additional for every $1,000 over the first. For every horse one dollar; hotels at a special rate according to the number of beds, also special rates for Factories, Machine Shops, Tanneries, &c., &c., which would give a revenue as follows:

1000	Vacant Lots at $	2.....................$	2000
750	Houses............	2.....................	1500
600	do	3.....................	1800
300	do	4.....................	1200
300	do	5.....................	1500
200	do	6.....................	1200
200	do	7.....................	1400
150	do	8.....................	1200
150	do	9.....................	1350
100	do	10.....................	1000
100	do	11.....................	1100
100	do	12.....................	1200
100	do	13.....................	1300

100	Vacant Lots at $	14	$1400
100	do	15	1500
100	do	16	1600
100	do	17	1700
100	do	18	1800
200	do	20	4000
50	do	30	1500
50	do	40	2000
20	do	50	1000
10	do	80	800
5	do	100	500
2	do	150	100
2	do	200	400
1	do	400	400
			$36650
Parliament Buildings			4000
Corporation fountains, &c			6000
Railway			1500
Machine shops, &c			1000
Horses			1000
Total revenue from Water Works			$50120

Your Committee submit that at the above rates the water works would yield a revenue in excess of the expenditure of $7,075, or 16½ per cent over and above the expenditure, leaving a large margin for contingencies; and you will mark that Your Committtee have, in all instances, taken the larger figures against them, and the lowest in their favor, and therefore not the slightest fear of increased taxation by the building of Water Works.

Under those circumstances Your Committee deem the building of Water Works desirable in a pecuniary point of view, and if our city progresses at the same rate that it has during the past year Your Committee are of opinion that within a few years the water rates can be materially lowered, not taking into consideration the benefits in a sanitary direction, nor the decrease in rents consequent upon the lessening of insurance rates, and the necessity of them to beautify and adorn our city, the metropolis of this great, growing, and prosperous Dominion.

All of which is respectfully submitted.

WILLIAM MOSGROVE,
Chairman.

H. LAPIERRE.
G. TAILLON.
J. R. O'CONNOR.

ENGINEER'S REPORT.

WILLIAM MOSGROVE, Esq.,
Barrister at Law,
Alderman, Chairman of
Water Works Committee, &c., &c.

SIR,

In accordance with your instructions of 4th March, I have the honor to submit the following Report on Water Works for the City of Ottawa.

I have the honor to be, Sir,
Your obedient Servant,

G. H. PERRY, C. E.

CITY ENGINEER'S OFFICE, City Hall,
Ottawa, 21st March, 1871.

REPORT ON WATER WORKS FOR THE CITY OF OTTAWA.

In order to understand the value of the various systems in use for artificial supplies of water, it will be necessary to describe the agencies available for that purpose, and in this connection the element itself demands the first consideration.

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In order to understand the value of the various systems in use for artificial supplies of water, it will be necessary to describe the agencies available for that purpose, and in this connection the element itself demands the first consideration.

Water has no motion of its own; its *force* or *power* is due to gravitation and acquired by the momentum of its weight. Hence to lift *water* by *water*, motive power must be acquired by allowing it to fall from a height under circumstances which will enable a greater *force* to *descend* than the force or weight ascending. Where the conditions necessary to accomplish that end exist the best motive power is to be found.

Steam, which is simply water expanded, acquires its force from heat—by which it is enabled to accomplish the same amount of work as the natural agent with a far less expenditure thereof, and is applicable in all cases where water is not plentiful, or where natural causes prevent its profitable application. These are the only agencies which can be relied on to furnish *continuously* the motive power or force requisite to keep up a constant artificial supply of water—giving steady and uniform results.

What is known as the general systems of water works may be classed under two heads, viz:—That available by simple *gravitation* and that available by *pumping* which latter is an inversion of the former, the power or force being employed below instead of from above.

In the first instance, water, when confined, will rise nearly to the *level* of the source from which it is derived and this principle has been rendered available without the aid of interposed machinery. At various places, notably at the City of Quebec, it is known as the Gravitation system. At Montreal a modification of that system exists; water is pumped by water (and steam power occasionally) into a large reservoir from whence it is distributed by gravitation alone. At Hamilton the same operation is performed solely by steam power; this is known as the *high pressure* pumping system with *gravitation*. There are variations thereof; for instance, at Montreal the combined water and steam power is occasionally employed in pumping directly into the main pipes, leaving the reservoir for contingencies.

Within the last *ten* years a very important modification of the combined pumping and gravitation system has been effected by the substitution of rotary pumps, and other mechanical arrangements by which reservoirs can be dispensed with altogether, and a *constant* supply forced into the main and service pipes with as satisfactory results as the gravitation system could afford, and far more than could be derived from its combination with pumping. This is simply the *High Pressure Service System*, and is known as the *Holly System*, and several very satisfactory works have been erected in various towns and cities in the United States. Its chief features may be briefly summarized as its cheapness, efficiency and reliability. The water being constantly in motion cannot freeze, it dispenses with costly reservoirs but involves machinery having incessant action. The rotary pump, enabling a steady and equal pressure to be applied, obviates in a great measure the evils produced by what is known as the *water hammer*, which is compressed air forced into the pipes by plunger pumps and is frequently the cause of disastrous ruptures. As a system it is simply the improvement of one in use for many years in English towns and villages known as the *Low Pressure Service*, water being forced by pumps through pipes at small elevations into the basement or lower storeys of houses.

The topographical features of the City of Ottawa and the surrounding country precludes the possibility of securing a water service by *gravitation*, and as the modification involves the construction of a costly reservoir which would not answer all the requisite conditions, compels the adoption of the high pressure, or *Holly System*, and the same natural cause limits the source of supply to the *Ottawa River*, as well as the site of the necessary machinery to any of the following localities, viz:

At Pooley's Bridge.
" Foot of Oregon Street.
" Amelia Island.
" Victoria Island.
" Foot of Little Chaudiere Rapids.

The level of the highest point in the city (north of the *Old Hospital*, in rear of the Western Departmental Block), is 168.92 feet above the sill of the lowest lock on the Rideau Canal—the level of the crown of the dam to Russell Island, above the same point, would be 43.89 feet; the difference would be 125.03 feet; at which the highest elevation in the city stands above the ordinary water in the bay; but as the Ottawa River has been known to rise 24 feet above the sill of the lowest lock, an available fall of 20 feet is all that can be reckoned on with safety in calculating the power or placing the machinery, and that fall would be available at all the above sites except the Little Chaudiere, at which it would be barely *seven* feet.

In order to make these sites available artificial channels will have to be excavated as conduits of the following lengths, viz.:—

Through the Gully for 3,400 lineal feet.
" Queen street " 2,400 "
" Oregon " " 1,450 "
" Amelia Island " 250 "
" Victoria " " 50 "

And at Little Chaudiere, a *built flume*, or conduit of wood, for 1,800 lineal feet.

Those distances will allow of channels being constructed from a depth of *ten* feet at *low water* in the *bay* to the sites of the power; in other words, to those points where the surplus or tail waters from the machinery could be got rid of, which will by the *three* first be through the gully below Pooley's Bridge; the fourth through the slide channel, and the fifth through the *cavern* at the *Victoria* foundry. The sixth delivers its tail waters into the bay.

To arrive at a correct knowledge of the size of channel required to supply the necessary power, the amount of *work* to be performed must be first considered. It is usual in making calculations for a supply of water to estimate an allowance of *thirty* gallons per diem for each head of population. Taking the number of people in Ottawa at 25,000, the supply should equal 750,000 gallons. The experience of neighboring cities proves that fully as much more will be allowed to run waste, and it will be necessary to provide for contingencies, extra supplies, &c., an amount equal to that provided for the people, so that the full quantity required would equal 2,500,000 gallons per diem. A cubic foot of water weighs 62.5lb, and contains a little over six gallons. Taking the gallon, however, at 10 lbs. weight, and the ton at 2,000 lbs., we have a total weight to be lifted of 12,500 tons every *twenty-four hours*. The summit of the

Parliament Buildings are, say, *ninety fect* above the level of the highest point in the city, and contingencies may arise which would compel even *twenty-four* feet higher to be attained. Therefore the full height of 240 feet is that to which the above weight has to be lifted, at the rate of 8.68 tons per minute, equal to 4.166.640 lbs. raised *one* foot high in the same time. The dynamic unit defining power is that of 33,000lbs. raised *one* foot in a minute. It is called a *horse power* from the supposition that it is equal to the continuous efforts of that animal in *ten* hours work; and it would therefore require a motor of 127 horse power to effect the above work. In the practical application of water power, no machinery has yet been invented that will give out more than 75 per cent. of the force actually applied to it; therefore it will require *two hundred* horse power to perform the above work. There are other elements to be taken into consideration which would further reduce the effective force, but as the *power must be continuously* applied under the *Holly system*, a duplication is a necessity. It is usual to calculate for water power that *two feet* of *head* is only equal to *one foot* of fall in effective force; therefore at any of the five sites named there would be only in reality *fifteen* feet of fall with *ten* feet head. A sluice way *five feet* in length by *one foot six* inches wide will supply on a head and fall of *fifteen* feet 202 horse power. In order to insure sufficient supply for *duplication*, and a reserve for additional power, *four times* the theoretical width is taken as what should be the practical breadth of conduit, or *twenty* feet.

In order, if possible, to obviate the difficulties which have been experienced in other cities where water power is used, by *ice-damming* in winter, *ten feet* is fixed as the depth of conduit which is capable of delivering with a velocity of 150 feet per minute 30,000 cubic feet of water, the quantity theoretically required for the power being 7,114 cubic feet.

The theoretical amount of work to be done, with the corresponding agencies, having been defined, the mode by which it is to be distributed demands the next consideration. The size of the water pipes will necessarily be determined by the quantity of water to be delivered through them, thickness and consequent weight and value by the pressure they will have to sustain. A supply of 2,500,000 gallons per diem is equal to 1,736 per minute, or nearly 289 cubic feet of water. This quantity has to be *lifted* to a height of *ninety feet* as a minimum, and *two hundred and forty* feet as a maximum. In this operation the consideration of conditions decides that the first effort will be to comply with the natural conditions of "water rising when "confined to its own level," and, as a consequence, the surface height to be attained must be deducted from the *assumed height* to give the degree of *pressure* on the distribution necessary to define the capacity of the *leading main pipe*. The surface of ground will be *eighty feet* above the level of the water in the bay, which leaves *ten* feet as the *initial* pressure in the main for distribution, the remainder of the power being merely applied to balancing a column of water of *eighty feet* in height. As the first length of main pipe will be 5,000 feet, with *ten feet* pressure, an 18 inch pipe would discharge 286 cubic feet of water per minute. It will be necessary for the distribution to carry on those mains in a diminishing ratio proportioned to the amount of population to be served under the same circumstances. With 5,000 feet additional pipe a 15-inch pipe would discharge 128.73 cubic feet per minute, and a 12-inch pipe, with 5,840 feet added to the former lengths, would discharge 58.90 cubic feet per minute. In order to raise the weight of 286 cubic feet to a height of 90 feet above the water in the bay, a force equal to 48.75 H. P. will be required, and to a height of 240 feet 133 H. P. Under a *twelve* foot head the discharge would be 313.62 cubic feet per minute, requiring 141 H. P. to raise it to the higher level. This calculation, while fixing the size of the leading main pipes, confirm the dimensions of the conduit.

The quantity of water delivered by the 18-inch main would be 2,500,000 gallons; by the 15-inch, 1,113,768; and by the 12-inch, 505,440 gallons per diem. For distribution the 18-inch pipe would supply 1,886,232; the 15-inch, 608,328; and the 12-inch, 505,449 gallons in the same time. Taking one-*third* as supply for population, the 18-inch pipe would give 462,077 gallons. At 30 gallons per head it would supply 15,402 persons; the 15-inch, 203,771, supplying 6,758 persons; the 12-inch, 168,489, would supply 5,616 persons, making a total of 27,766 persons which could be supplied by the power and capacity indicated.

Taking the probable distribution of population, but limiting the number to 25,000 souls, it would be as follows: Victoria Ward, 4,000; Wellington, 4,750; St. George, 4,750; By-Ward, 5,500; Ottawa Ward, 6,000. As the pumping machinery will be in Victoria Ward, the proportion supplied by the leading main will have to supply that Ward, Wellington, *half* of By-Ward, and half of Ottawa Ward, making a total of 14,500 persons. The 15-inch pipe will supply *one-half* St. George's Ward, *one-fourth* By, and *one-third* Ottawa Ward—Total, 5,750; and the 12-inch pipe will supply *one-half* St. George's, *one-fourth* By, and *one-sixth* Ottawa Ward—Total, 4,750 persons.

The disposition of the main pipes is a matter of considerable importance, inasmuch as with the exception of the *Barrack Hill* the southern face of the city from Bay street eastwards stands generally at a higher elevation than the northern side or that washed by the Ottawa river—the location of the mains must, as a matter of economy, take the higher side, such a disposition materially affecting the calibre and cost of the *sub-mains* by the additional pressure secured —which will range from *twenty* to *fifty* feet.

I should advise, therefore, that the mains be carried along the general direction of Maria and Theodore streets, from the wheel house, to their full length, a distance of three miles, and that disposition be made in the construction of the *proposed bridge* connecting those streets across the Canal to carry the *mains* within its superstructure instead of dipping them under it. A good deal of rock cutting will thus be avoided and the necessity of at least two changes in the level of the mains. I would also propose to supply the Parliament and Departmental buildings with an independent main *eight inches* in diameter. The sub-mains, of which there are two, will be of *six inches*. Such a pipe, with 60 feet of pressure, will discharge at a length of 4,000 feet 50.77 c. feet of water per minute, which would supply a population of 4,873 persons. The remainder of the pipes should be 4 inch, 3 inch, 2 inch, under the same pressure and with a length of 600 feet, the first will discharge 46 c. feet per minute, the second, 23, c. feet, and the third, 8 c. feet.

Having established the calibre of the pipes it will be now necessary to determine their thickness. A column of water 250 feet in height and 18 inches in diameter will exert a pressure of 109 lbs. to the square inch. The thickness due to resist that pressure would be *one-third* of *an inch*, but in practice it will be necessary to guard against contingencies which are constantly arising, inasmuch as the pressure or strain on the pipes is never equal. *One* inch in thickness would be, therefore, the least that could be recommended as thoroughly safe. The 15 inch pipe should be ⅞ inch, the 12 inch pipe ¾ inches, the 8 inch ⅝, as should also be the 6, 4, and 3 inch, and the two inch pipe ½ inch in thickness. It should be remembered that those pipes are considerably weakened by *tapping* for house service, hydrants, and other purposes that they deteriorate rapidly in use, and that it is necessary where the force is intermittent to provide against its probable greatest effort as well as against other contingencies. The data being now ready for calculating cost, it is as follows:

5,000	feet...	18+1.....	186.24	lbs. per foot lineal	931,200	lbs.
5,000	"	...15+⅞....	156.82	" "	784,100	"
5,840	"	...12+¾.....	93.75	" "	547,500	"
5,200	"	.... 8+⅝.....	52.68	" "	273,936	"
9,800	"	... 6 ".....	40.56	" "	397,488	"
52,800	"	... 4 ".....	28.28	" "	1,493,184	"
47,520	"	... 3 ".....	22.15	" "	1,052,568	"
11,400	"	... 2 ½.....	12.23	" "	139,422	"
142,560				lbs.	5,619,398	

The cost of those pipes will vary with the market. In 1869 they were delivered at Montreal at 1⅞ cents per lb.; at the same time in Hamilton the cost was 2$\frac{68}{100}$ cents. Taking into account the difference of freight and cost of caulking it would not be safe calculating at a less sum than 2½ cents per lb., especially as they have to be handled repeatedly. Water pipes are generally laid in lengths of *nine* feet. The joints will take an average of 8 lbs. of lead; in the length of pipe to be laid there will be 15,840 joints involving an outlay of 126,720 lbs. of lead at 6 cents per lb.—$7,603.20. Adding to the price at Montreal $\frac{13}{100}$ of a cent per lb., which would raise the price at one to two cents without taking other contingencies into account. The cost of the mains and distribution would be, therefore, at 2½ cents per lb., $140,484.95

To this sum must be added, 1st, the cost of House service; 2nd, cost of stop-cocks; 3rd, cost of hydrants. At Montreal the cost of house-service pipe laid is 28 cents per lineal foot,—calibre five-eight-inch and weight three pounds per foot. At Hamilton most of the service pipes are lead, one-half inch calibre, and the cost per house is $17.

In Victoria Ward there would be 650 houses, in Wellington 800, in St. George's 800, in By 900, in Ottawa 1000, total 4,150 houses; taking each house service with tap and everything complete as being worth $15, there is a sum of $62,250 to be added. The number of stop cocks will be the same as the number of hydrants. Placed 500 feet apart there would be 300 of each; the cost of stop cocks laid being $30, this item would amount to $9000; the hydrants will cost $60 each—$18,000, so that the total of the water service will be as follows, viz:—

Main and distribution pipes	$140,484	95
House service	62,250	00
Stop-cocks	9,000	00
Hydrants	18,000	00
	229,734	95

This calculation has been based on the assumption that the pumping machinery will be placed at Pooley's Bridge that being the nearest point at which the motive power can be concentrated.

In order to obtain that power it will be necessary to excavate a channel for a conduit through the gully, and from motives of economy, cleanliness and precaution cover it with a substantial arch of masonry, restoring the surface as far as possible and constructing two drains, one on each side, parallel thereto for carrying off the sewerage water from the neighbourhood.

From Pooley's Bridge to *ten* feet at *low water* is a distance of 3,400 feet; of this length 3,000 feet are above water and will involve an excavation of 14 feet average depth with a width of 24 feet, say 37,800 cubic yards of clay and rock. The latter predominates. Two walls 3000 feet each in length, 12 feet high and two feet thick an arch of same length, with 6,000 feet of pipe drain, the total cost would be as follows:—

Excavation	37,800	cubic yds.,	at 90	$34,020
Walls	5,400	“	“ 5.00	27,000
Arch	2,700	“	“ 6.50	17,500
Drains	6,000	“	“ 2.50	15,000
Right of way, 2 acres		“	4,000.00	8,000
				101,520

The cost of arching would equal $14.83 per lineal foot.

The conduit through Queen street to Pooley's Bridge would measure 2,400 feet, of which 2,000 feet would be over water, the cutting would average 20 feet in depth, width 24 feet with arches and sewers to correspond, its cost would be as follows, viz:—

Excavation	35,600	cubic yds., all rock	$1	$35,600
Arching	2,000	lineal feet,	$14.83	29,700
Sewers	4,000	“ “	2.50	10,000
				75,300

The route through Oregon street would involve a length of 1,450 feet above water, a quantity of excavation equal to 31,500 cubic yards, a corresponding length of arch and sewer, and the purchase of the right of way between Bridge street and Brittania Terrace, as the tail water should be discharged into the west branch of the gully it is probable the machinery should stand on the lots acquired, it involves 960 feet of extra leading main; its cost would be therefore as follows;—

Excavation	31,500	cubic yds., rock,	$1,00	$31,500.00
Arching	1,450	lineal feet,	14.83	21,503.50
Sewers	2,900	“ “	2.50	7,250.00
960 ft. mainpipe, 18×1—178,090 lbs., at 2¼				4,472.25
Right of way				8,000 00
				72,725.75

The proposed site at Amelia Island would cost for excavation probably $12,000, arch way 200 feet, and an additional length of main of 1,350 feet, its waste water will be delivered into the slide channel, but the site is on Government property; if the works were erected they would require all the water in the slide channel and materially affect the supply to the adjacent mills. The full cost under the circumstances, could not be obtained, but it would stand comparatively with the others as follows;—

Excavation	$12,000	00
Arching 200 lineal feet, $14,83	2,966	00
1,350 feet extra main, 251,424 lbs., at 2½	6,285	50
	$21,251	50

Another site is to be found on the west side of the slide channel on Victoria Island. It combines many advantages, with several disadvantages: the former are its delivery of the tail water into the cavern at the Victoria Foundry; the absence of excavation and arching; the disadvantages are its confined site; the necessity of drawing the motive power from private ponds, and the distance pure water must be brought from. It has not been possible to arrive at the full cost of what this *measure* might be, in consequence of the extended examination necessary, the difficulty of dealing with parties in the possession of mill privileges and rights, and the certainty that those would be interfered with by the construction of the works. The comparative cost would be:—

Excavation	$ 9,000	00
Arching	2,000	00
A built flume, 200 feet, at 8	1,600	00
Say for right of water	10,000	00
1,350 feet extra main	6,285	50
	$28,885	50

but those results are not reliable.

The last site is at the foot of the Little Chaudiere Rapid. The works are supposed to be erected 1,800 feet east of Sparks old mill. The fall will be only *seven feet*, and a *built flume* must serve the purpose of a conduit. Its size, as determined by the principle laid down, would be 36 feet wide. It would be necessary to lay down an additional main for 6,000 lineal feet to connect the power at this site with the distribution and service in the city. The cost would be as follows:—

Flume, 1,800 lineal feet, at $8	$14,400 00
6,000 feet extra main, 1,117,440 lbs., at 2½c.	27,936 00
Land damages	25,000 00
	$67,336 00

In this calculation no account is taken of the mill privilege destroyed.

The cost of excavation for laying the water pipes is a serious item. It varies with the circumstances of soil and rate of wages, but in order to lay pipes so that they will not suffer in the operation, nor subsequently by subsidence, both skill and care are required. They must, moreover, be laid with regular grades, and at a sufficient depth to avoid accident by frost. Wherever rock is to be found it will be necessary to lay the pipes in either sand or sawdust, in order to prevent the consequences of loose packing, and the refilling of the excavations must be performed with the greatest care.

In Montreal the cost of excavation and refilling is as follows:—

24-in. pipes, 0.55; 16-in., 0.48; 12-in., 0.42; 10-in., 0.27; 8-in., 0.20; 6-in., 0.17; and 4 in., 0.17 cts. per lineal foot in clay, with $1.00 extra per cubic yard for rock. At Hamilton the cost of excavation and filling for a 6-in. pipe five feet below the surface in clay is 12½ cents per lineal foot. Taking into account the quantity of rock to be met with in laying pipes in Ottawa, as well as the character of the excavation generally, and knowing that a minimum depth of *five feet*, the lowest that can be given with safety, will involve a far greater average, I am of opinion that this item will be covered by the following rates: In rock excavation and refilling for 18-in. pipe, $1.00; the same for 15-in.; for 12-in., 0.85; 6-in., 0.75; 4-in., 0.70 cts.—in clay, gravel, &c.; 18-in., pipe, 0.50; 15-in., 0.48; 12-in., 0.44; 8-in., 0.25; 6-in. and all the lower sizes, 20 cents per lineal foot.

Taking the leading main through the line of Maria and Theodore streets, the cost would be as follows:—

18-in. pipe,	1,000 lineal feet,	$1.00......	$ 1,000 00	
8 "	3,000 "	0.80......	2,400 00	
6 "	5,000 "	0.75......	3,750 00	
4 and 3-in	44,000 "	0.70......	30,800 00	
Total cost of excavation in rock.............				$37,950 00
18-in. pipe in clay,	4,000 at	0.50......	2,000 00	
15 " "	5,000 "	0.48	2,400 00	
12 " "	5,840 "	0.44......	2,569 60	
8 " "	2,200 "	0.25......	550 00	
6 " "	4,809 "	0.20......	960 00	
3 and 8 "	67,720 "	0.20......	13,544 00	
Total cost of excavation in clay.............				22,023 60
Total cost,....................................				$59,973 60

The subject next for consideration is the supply of *pure* water. It cannot be taken from the bay for obvious reasons —large quantities of timber pass down there every season, and the water is more or less polluted. This evil will be increasing, especially as it is reasonable to expect advantage will be taken of the capabilities of the *Grande Riviere* for commercial purposes. A Canal affording access to the bay would reduce it to a harbor at once, and would compel, at a period when it would probably cost a heavy sum of money, with considerable doubt if any privilege would be conceded, the construction of the necessary works for filtering. At present such a structure can be erected at a moderate outlay, and it is the only means whereby pure water can be obtained. I would, therefore, advise that a space of 200 feet square in *ten feet* water be enclosed by a substantial coffer dam, provided with sufficient sluices and machinery, to stand at least six feet above high water, and that it should enclose an inner space of 50 feet in its centre, the walls of which would be either of wood or stone, but in any case perfectly water-tight, as a well. It must be covered over, and have sufficient sluice ways to admit the water from the filtering beds, which would occupy the space between both structures, covering an area of 37,500 sq. feet. This space should have a depth of *five* feet of the following material, viz. :—

One foot fine broken stones.
One foot coarse gravel.
One foot fine gravel.
One foot best wood charcoal.
One foot moderately coarse sand.

Every *one hundred* square feet of this surface will furnish 50 c. feet of pure water per hour. The face of the sluices to the well should be covered with perforated plates of galvanized iron, and the water purified would be sent to the pumps by an iron pipe *two* feet in diameter laid in the bottom of conduit. The cost of this structure and filter would be :—

Outer walls, 800 lineal feet at $10	$ 8,000 00
Inner walls, 200 " " 20	4,000 00
Filter and fittings	1,000 00
Total	$13,000 00

The cost of supply pipes would be for *two feet* in diameter $6.13 per foot :—

The Gully Route,	3,400 feet	$20,842 00
The Queen street route,	2,400 feet	14,712 00
The Oregon street route,	1,450 feet	8,888 50

The other sites appear to be altogether out of calculation in this matter. On two of them, viz. : at Amelia Island and Victoria Island it would be absolutely necessary to lay a supply pipe out to Russell's Island, and the difficulty of that operation can only be imagined. The same may be said of the Little Chaudiere, the small depth of water in the flume being an insuperable objection in winter, and except for mere purposes of comparison they are out of account. Further investigation, however, may develop greater advantages, but the question of expense appears just now to be narrowed to two sites—"that at Pooley's Bridge, and that at the foot of Oregon street," with the connecting routes.

The managers of the Holly works have offered to put in machinery at any point prepared by the Corporation for water works capable of working up to 500 horse power, with all the necessary apparatus of their system, for $25,000. The buildings necessary would cost about $20,000, so that the actual cost of a system of water supply driven by water power for the city of Ottawa can be arrived at—the four latter charges being common to the first three routes:—

By the Gully:—

Cost of distribution, &c	$229,734	95
" excavation for do	59,973	60
" conduit	101,520	00
" settling bed	13,000	00
" supply pipes	20,842	00
" machinery	25,000	00
" wheel house, &c	20,000	00
	$470,070	55

By Queen street:—

Cost of distribution	$229,734	95
" excavation	59,973	60
" conduit	75,300	00
" settling bed	13,000	00
" supply pipes	14,712	00
" machinery	25,000	00
" wheel house, &c	20,000	00
	$437,720	55

By Oregon street:—

Cost of distribution	$229,734	95
" excavation	59,973	60
" conduit including extra main	72,725	75
" 960 feet of excavation for extra main	960	00
" settling bed	13,000	00
" supply pipe	8,888	50
" machinery	25,000	00
" wheel house	20,000	00
	$430,282	80

The above estimates are sufficient to build those works at the sites indicated to be driven by water power. There would remain to be added to each 10 per cent for contingencies, and at least one year's interest at 7 per cent. Their cost would then stand :—

By the Gully route, cost	$470,070 55
Contingencies. 10 per cent	47,007 05
	$517,077 60
Interest at 7 per cent, 1 year	36,194 53
	$553,272 13
By Queen street, the cost will be	$437,720 55
Contingencies, 10 per cent	43,772 05
	$481,492 60
Interest at 7 per cent, 1 year	33,704 48
	$515.197 08
By Oregon street, cost	$430,285 80
Contingencies, 10 per cent	43,028 28
	$473,311 08
Interest at 7 per cent, 1 year	33,131 77
	$506,442 85

I would direct attention to the fact that the proposed machinery must be kept constantly in motion by a very large stream of water, moving at a rate of two miles per hour to supply the motive power, and that no person has yet worked machinery on the various sites in this city throughout the winter to the extent of 200 horse power constantly, and double that as a contingency.

In Montreal, from well known causes, the water power has to be supplemented with steam and in Ogdensburgh they have been obliged to erect the same, as auxiliary power to guard against contingencies during the cold season.

Those considerations have led to the conclusion that it was within the probabilities that similar phenomena might be developed after the erection of the proposed water-power, and the additional cost added of constructing the auxiliary at a time when it would be inconvenient, attended with great risk and entail considerable loss. I, therefore, submit to the Committee whether it might not be advisable to take into serious consideration the project of having the water supplied by steam power in the first instance and leisurely proceed with the important measure of excavating the conduit and erecting the buildings for water power, which would be the permanent *motor*. As a precautionary measure I believe this course would be advisable, and, as the Chairman has suggested, I herewith append an estimate therefor, premising that the Engine House should be built over the well in settling bed, and the additional main pipe would be the only feature in the new arrangement.

Cost of steam power:

Cost of distribution	$229,734	95
Cost of excavation	59,973	60
Cost of additional main through Queen Street, 2,400 lineal feet, $4.66	11,184	00
Extra on foundation of well	1,500	00
Excavation for pipes	2,400	00
Engines and machinery	50,000	00
Engine House	20,000	00
	374,792	55
Contingencies, 10 per cent	37,479	25
	412,271	80
1 year's interest, 7 per cent	28,859	02
	444,130	82

A very considerable saving could be made on this estimate in the purchase of the engines, which should be two condensing engines of 100 horse-power each, and also in the *Holly* pump and machinery attached to the power, as well as in the engine house. This, however, would be a matter for the consideration of the Committee, and I merely point it out to show that this project has been put on no *vantage* ground. I am of opinion that if experience proved the water power could be safely worked during an average winter, the material of the steam power could be disposed of advantageously.

The cost of working the machinery by steam and water will determine the value of each. At Hamilton there are two engines having to lift 185 feet to reservoir. The work effected equals 620,000 gallons per day of *eleven* hours, with an engine working at 60 H P. The cost of labor is $5.00, and of fuel, 4,170 lbs at $6.70 per ton of 2,000 lbs., $13,54. Total cost, $18.54. The cost here continuously would be proportionably less. The article of fuel alone could be reduced considerably, and it should not cost more than $25 per diem. The labor about the machinery with water power will cost at least $12.50 per day. The difference between the first cost of both powers, taking it at the most feasible, that by Queen street, would be:—

Water power	$437,720 55
Steam "	374,792 55
Difference	$ 62,928 00

the interest on which would be, at 7 per cent, $4,404.96 per annum. The difference of cost of working the steam power would be $12,50 per day, or $4,562.50 per annum, leaving a balance of $157.54 against steam power, a sum which might be very considerably reduced by using *artificial* fuel manufactured from sawdust and crude petroleum.

It appears to me that the question of sites is narrowed down to that of the lot at Pooley's Bridge. At Oregon street, in addition to its confined position, the opening of the conduit would be in the mouth of the slide channel, and it would be attended with many inconveniences. The land at both sides of Britannia Terrace is private property, and its purchase may interfere with the future development of manufacturing power there. At Pooley's Bridge the site belongs to the Corporation.

The cost of the proposed measure can be best comprehended by comparison with existing works. At Hamilton the gross cost has been $840,000. With 22,000 inhabitants it would be $38.18 per head. At Montreal it has exceeded $25 per head. The proposed works at Queen street would cost by steam power $17.64 per head; with water the same cost would be $20.50 per head. Taking the highest sum (for the latter) at $437,720.55, the interest at 7 per cent, and sinking fund at 3 per cent, the amount to be raised annually would be $43,772.25. To this must be added cost of working, $12.50 per diem, $4,562.50, and 3 per cent for repairs, &c., $1,095.00, a total of $49,429.75 will have to be raised as revenue. Without taking into account public institutions or the use manufacturers will make of the water, but simply taking the average rate applied to the inhabitants, it would amount to just $1.97⅔ per head.

The question of Revenue is hardly within the scope of my instructions, but in order to shew that it will not be an exorbitant charge on the industry of the citizens, I may say that having the number of houses supplied and the basis of valuation taken at the lowest as being $400 a rate of $2 per house per annum, on houses and lots valued at that sum, with the same charge on vacant lots on each street having water pipes therein, $3 per lot for every house and lot from $400 to $1000, and $6 per house and lot to $4000; $10 per lot or house from $5,000 to $8,000; $20 per lot for all houses and lots valued over $8,000, and $40 per house and lot valued over $10,000, with a special average rate, say of $75 to $100 per house and lot on all factories, taverns, hotels and places where extra consumption of water would warrant the assessment. A general average would give on this assumption, which is supposed to include gardens, stables, and every case where an extra supply would be required, the following results :—

Say 1600	houses $	2	$ 3,200
800	"	3	2,400
600	"	6	3,600
500	"	10	5,000
300	"	20	6,000
200	"	50	8,000
100	"	75	7,500
50	"	100	5,000
			$40,700

Parliament Buildings	4,000
City	6,000
Railway stations	1,500
Total	$52,200

And it is quite probable that a more thorough examination which must precede actual assessment, would add considerably to this amount. The average house rate would be $9.80 each, for which 10,950 gallons of water would be received per head per annum.

The calculations are made for houses supposed to be occupied; vacant lots are not taken into account; there are over 7,000 lots within the city limits and the streets occupy about 5,020, making a grand total of 12,020; of this quantity 4,000 are occupied by houses and 1,462 by streets making 5,462 lots, or less than one-half the area of the city; the lots are taken at 66×99—6,534 square feet. There are 1803 acres enclosed within the limits, the proportion of streets due to which will be about sixty-one miles.

In 1860 I was employed by the Corporation to make a general survey with plans and estimates for drainage, Macadamization and water works; at that time the Holly System had not reached its present perfection, and a reservoir on the Barrack Hill was deemed the only means by which the city could be supplied. My estimated cost of water works was $418,717.20 including contingencies alone, and that only provided for 11,600 fèet of main with 85,000 feet of distribution pipes, a little over 14½ miles, the reservoir costing $161,173. The same work could not now be done at a less figure than 10 per cent of an advance on price of labour.

With proper precautions I believe the *Holly System* best suited to all circumstances of climate and position.

All which is respectfully submitted,

G. H. PERRY, C. E.

ENGINEER'S OFFICE, City Hall,
Ottawa, 21st March, 1871.